DEVELOPMENT OS SHAKER

(CONTROLLER)

MOHD HAFIEZAL BIN NORDIN

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ABSTRACT

The automatic control has played a role in the advance of engineering and science. Nowadays, the control of direct current (DC) motor is a common practice in industry thus the implementation of DC motor of controller speed is important. The main purpose of motor speed controller is to keep the rotation of the motor at the preset speed and to drive a system at the demanded speed. When used in speed application, speed feedback control the DC motor's speed or confirms that the motor is rotating at the desired speed. The speed of a DC motor usually is directly proportional to the supply voltage. For instance, if we reduce the supply voltage from 12 Volts to 6 Volts the motor will run at half or lower the speed. The advantages used DC motor is provide excellent speed control for acceleration and deceleration with effective and simple torque control. The fact that the power supply of a DC motor connects directly to the field of the motor allows for precise voltage control, which is necessary with speed and torque control applications. The common methods are used to control speed DC motor is Proportional Integral Derivative (PID) and PC based to control it. In this project, the method use as controller is using Arduino Uno as microcontroller for the electric current control to drive a motor. The expectation of this project is to get the precise the demanded speed and to drive a motor at that speed.

ABSTRAK

Kawalan automatik telah memainkan peranan dalam kemajuan kejuruteraan dan sains. Kini, kawalan arus terus (DC) motor adalah biasa amalan dalam industri itu pelaksanaan DC motor pengawal kelajuan adalah penting. Tujuan utama pengawal kelajuan motor adalah untuk memastikan putaran motor pada kelajuan yang ditetapkan dan untuk memandu sistem pada kelajuan yang diminta. Apabila digunakan dalam permohonan kelajuan, maklum balas kelajuan mengawal kelajuan motor DC atau mengesahkan bahawa motor yang berputar pada kelajuan yang dikehendaki. Kelajuan motor DC biasanya adalah berkadar terus dengan voltan bekalan. Sebagai contoh, jika kita mengurangkan voltan bekalan dari 12 volt ke 6 volt motor akan berjalan pada separuh atau lebih rendah kelajuan. Kelebihan digunakan DC motor menyediakan kawalan kelajuan yang cemerlang untuk pecutan dan nyahpecutan dengan kawalan tork berkesan dan mudah. Hakikat bahawa bekalan kuasa motor DC menghubungkan terus kepada bidang motor membolehkan kawalan voltan yang tepat, yang perlu dengan aplikasi kawalan kelajuan dan tork. Kaedah yang biasa digunakan untuk mengawal kelajuan motor DC adalah derivatif Penting Berkadar (PID) dan Komputer berasaskan untuk mengawalnya. Dalam projek ini, kaedah yang digunakan sebagai pengawal menggunakan Arduino Uno sebagai pengawal micro untuk mengawal arus elektrik untuk memandu motor. Jangkaan projek ini adalah untuk mendapatkan tepat kelajuan yang diminta dan untuk memandu motor pada kelajuan itu.

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CHAPTER 1

INTRODUCTION

1.1 Project Background

In many industries, a device that used in order to convert electrical energy into mechanical energy is called as the direct current (DC) motor. All result is from the availability of speed controllers which is wide range, easily and many ways. Speed control is very important in most applications, which is for an example, if we have DC motor in radio controller car, if we just apply a constant power to the motor, it is impossible to maintain the desired speed. It will go slower over rocky road, slower uphill, faster downhill and so on. It is important to make a controller to control the speed of DC motor in desired speed. In modern industry, DC motor plays a significant role.

Speed control of dc motor could be achieved using mechanical or electrical techniques. In the past, speed controls of dc drives are mostly mechanical. Requiring large size hardware to implement. Advances in the area of power electronics have brought a total revolution in the speed control of dc drives. This development has launched these drives back to a position of formidable relevance, which were hitherto predicted to give way to ac drives. These drives have now dominated the area of variable speed because of their low cost, reliability and simple control.

To take a signal representing the demanded speed, and to drive a motor at that speed is The purpose of a motor speed controller. There are numerous applications where control of speed is required, as in rolling mills, cranes, hoists, elevators, machine tools, transit system and locomotive drives. These applications may demand high-speed control accuracy and good dynamic responses.

DC motor is widely used in metallurgy, machinery manufacturing and light industry because of its good performance in starting and breaking and its easily controlled speed regulation. In recent years, with the development of the power electronic technology, the thyristor rectifier is commonly used for the power supply of the DC motor, which replaces the AC motor—DC generator power supply system. But DC motor speed control system is a complex multivariable nonlinear control system, because the various parameters influence each other, it’s anti—interference ability is weak and it’s not suitable for high control performance occasion.

Therefore, in order to enhance DC motor speed control system of anti—jamming and robustness, and improve the response speed and stable precision of the speed regulation system, this paper discuss the PWM DC motor speed control system based on the fuzzy control and neural network control.

In conclusion, in devices ranging from toys, house appliance and robotics to industrial application, the simplicity of control speed made DC motors to be common.

1.2 Objective of the Project

Basically, these projects are having three main objectives. The objectives are a guideline and goal in order to complete this project. This project is conducted to achieve the following objectives:

I. To develop controller using microcontroller as programming.
II. To design the hardware of the controller to control DC motor frequency.
III. To develop precisely control the DC motor.

1.3 Scope of the Project

There are two scopes in this project which is hardware development and software development. For the first scope which is hardware development there are three main section. First are to design a circuit that can integrate with MicroController, nest is to design a circuit for control speed of DC motor, and lastly for to design a circuit for the motor driver.

While For the second scope which is the software development, there are two main sections and that section are. Firstly try to simulate the control system using Multisim software, next develop a software or coding and integrate with Arduino uno.

1.4 Problem Statement

The efficiency and reliability are the most issue discusses in speed controller. In order to save cost, the efficiency element is important. The efficiency of speed controller is depending on method control system. The speed controller usually controls in analog system and an analog signal has a continuously varying value, with infinite resolution in both time and magnitude. For example, a 10 V is an analog and its output voltage is not precisely 10 V, changes over time, and can take any real-numbered value.

Similarly, the amount current drawn from a battery is not limited to a finite set of possible value. Analog signals are distinguishable from digital signals because the latter away take values only from a finite set of predetermined possibilities. DC motor widely used in speed control systems which needs high control requirement such as rolling mill, double-hulled tanker and high precision digital tools. So, it is crucial to control the motor speed in order to achieve good production.

One of the most common methods to drive a DC motor is by using PWM signals respect to the motor input voltage. Manual controller is also not practical in the technology era because it can waste time and cost. Operation cost regarding controller is got attention from industrial field. In order to reduce cost and time, we suggest making a controller based on computer because it is portable. The user can monitor their system at certain place without need to going to the plant (machine) especially in industrial implementation. From that, the man power can be reduced and reserve with computer which is more precise and reliable. The other product regarding this project where control motor via computer may be commercialized but their cost is very expensive. The hardware of this product may be complicated and maintenance cost is higher. The low cost electronic devices can be designed to make a speed controller system. So this thesis will select PWM to control the speed of DC Motor using witdh modulation

1.5 Thesis Outline

Chapter one, it discusses about introduction and overview about this project includes background, objectives and scope of projects.

Chapter two is explanations about literature review as study material and references. The topics that I have studied are about the other method of speed control to compare and analysis their advantages and disadvantages. From the literature review, knowledge can be gained thus implement in this project.

On chapter three, the methodology that I have done are discusses. This is explanations about the method used to complete hardware and software.

Chapter four are discusses of the result and analysis of this project. In this chapter also will explain how PWM is produce and how its control the speed of the DC motor.

Chapter five are describes conclusion and future recommendation to make this project greatly.

This thesis included with references and appendices. Also refer the further information about this project in references which is states the source and their authors. Datasheet of the components, photo and other information also placed on the appendices part.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Although a far greater percentage of electric motors in service are a.c. motors, the d.c. motor is of considerable industrial importance. Its speed can be changed over a wide range by a variety of simple methods is the principal advantage of a d.c. motor. With a.c motors, such a fine speed control is generally not possible. In fact, fine speed control is one of the reasons for the strong competitive position of d.c. motors in the modem industrial applications. In this chapter, we shall discuss the various methods of-speed control of d.c. motors.

2.2 DC Motor

DC motor has been widely used in many application because it can maximize torque in order to generate movement. DC motor is mechanically commutated electric powered from direct an example of DC motor is shown in Figure 2.1. DC motor consist of motor and stator part, it also involve commutating process that switched the current in rotor. The introduction of DC motors to run machinery eliminated the need for local steam or internal combustion engines, and line shaft drive systems. DC motors can operate directly from rechargeable batteries, providing the motive power for the first electric vehicles.

Figure 2.1: DC Motor

Source: www.cytron.com.my

Electric motors play a main role in our daily life. The movement of any device is produced by electric motor. Hair dryer, VCR, disk drive in a computer etc, move due to electric motor. Electric motors can be divided into two basic groups, Direct Current (DC) motors, and Alternating Current (AC) motors. Although there are many designs of electric motors, the fundamental is the same. The technology behind electric motors is the ability to convert electrical energy to mechanical energy.

A *DC motor* is a mechanically commutated electric motor powered from direct current (DC). The stator is stationary in space by definition and therefore its current. The current in the rotor is switched by the commutator to also be stationary in space. This is how the relative angle between the stator and rotor magnetic flux is maintained near 90 degrees, which generates the maximum torque.

The printed circuit board (PCB) motor, using permanent magnet, has a configuration radically different from that of the conventional DC motor. The entire armature winding and the commutator are printed in PCB disk (rotor). This type of motor has several advantages such as high torque that allows it provides rapid acceleration and deceleration. The motor can accelerate from 0 to 4000 rpm in 10 milliseconds. The motor has no cogging torque because the rotor is nonmagnetic.

These motors are particularly suitable for applications requiring high performance characteristics. There are other types of DC motor that have their own advantages and disadvantages. The variety of DC motor types give a variety of control method and also the variety of application that can be performed. In conclusion, DC motors have many types and differ with each other in characteristics of the motor and also the use the motor in appliances. There are several types of DC motors that are available. Their advantages, disadvantages and other basic information are list below in the table below.

Table 2.1: Advantages and Disadvantages of various type DC Motor

TYPE	ADVANTAGES	DISADVANTAGE
Stepper Motor	Very precise speed and position control. High torque at low speed.	Expensive and hard to find. Required a switching control circuit.
DC Permanent Magnet Motor	Small. Compact Easy to find Very inexpensive	Generally small. Cannot vary magnetic field strength.
DC Motor W/field coil	Wide range of speed and torque. More powerful than permanent magnet motors.	Require more current than permanent magnet motors, since field coil, must be energized. Generally heavier than permanent magnet motors. More difficult to obtain.

2.3 Controller

Controller is a chip, an expansion card or a stand-alone device that interfaces with a peripheral devices. This may be a link between two part of a computer for example a memory controller or a controller on an external device that mange the operation of the device. Most microcontrollers at this time had two variants. One had an erasable EPROM program memory, with a transparent quartz window in the lid of the package to allow it to be erased by exposure to ultraviolet light. The other was a PROM variant which was only programmable once; sometimes this was signified with the designation OTP, standing for "one-time programmable".

The PROM was actually exactly the same type of memory as the EPROM, but because there was no way to expose it to ultraviolet light, it could not be erased. The erasable versions required ceramic packages with quartz windows, making them significantly more expensive than the OTP versions, which could be made in lower-cost opaque plastic packages. For the erasable variants, quartz was required, instead of less expensive glass, for its transparency to ultraviolet glass is largely opaque to UV but the main cost differentiator was the ceramic package itself.

The use of micro controller for speed control and protection of dc motor is presented in this paper. The peculiarity of this method is its adaptability to different ratings of motors. By using mechanical or electrical techniques, speed control of dc motor could be achieved. The speed controls of dc drives are mostly mechanical in the past and requiring large *size* hardware to implement. Advances in the area of power electronics have brought a total revolution in the speed control of dc drives.

This development has launched these drives back to a position of formidable relevance, which were hitherto predicted to give way to ac drives. These drives have now dominated the area of variable speed because of their low cost, reliability and simple control. DC drives are widely used in applications requiring adjustable speed; good speed regulation and frequent starting, braking and reversing. Some important applications are: rolling mills, paper mills mine winders, hoists, machine tools, traction, printing presses, textile mills, excavators and cranes. Fractional horsepower dc drives are widely employed -as servo means for positioning and tracking. [1]

By controlling armature or field excitation, adjustable speed drives may be operated over a wide range. Speeds below rated by armature voltage control and above rated using field excitation variation, development of various solid sates switching devices in the form of diodes, transistor and thyristor along with various analog digital chips used in firing controlling circuits, have made dc Drives more accessible for control in innumerable areas of applications. [2]

Every electric motor has to have some sort of controller. The motor controller will have differing features and complexity depending on the task that the motor will be performing. The simplest case is a switch to connect a motor to a power source, such as in small appliances or power tools. The switch may be manually operated or may be a relay or contactor connected to some form of sensor to automatically start and stop the motor. The switch may have several positions to select different connections of the motor. This may allow reduced-voltage starting of the motor, reversing control or selection of multiple speeds.

Overload and over current protection may be omitted in very small motor controllers, which rely on the supplying circuit to have over current protection. Small motors may have built-in overload devices to automatically open the circuit on overload. Larger motors have a protective overload relay or temperature sensing relay included in the controller and fuses or circuit breakers for over current protection. An automatic motor controller may also include limit switches or other devices to protect the driven machinery. A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor.[3]

More complex motor controllers may be used to accurately control the speed and torque of the connected motor (or motors) and may be part of closed loop control systems for precise positioning of a driven machine. For example, a numerically controlled lathe will accurately position the cutting tool according to a preprogrammed profile and compensate for varying load conditions and perturbing forces to maintain tool position. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults. [4]

2.4 Pulse Width Modulation

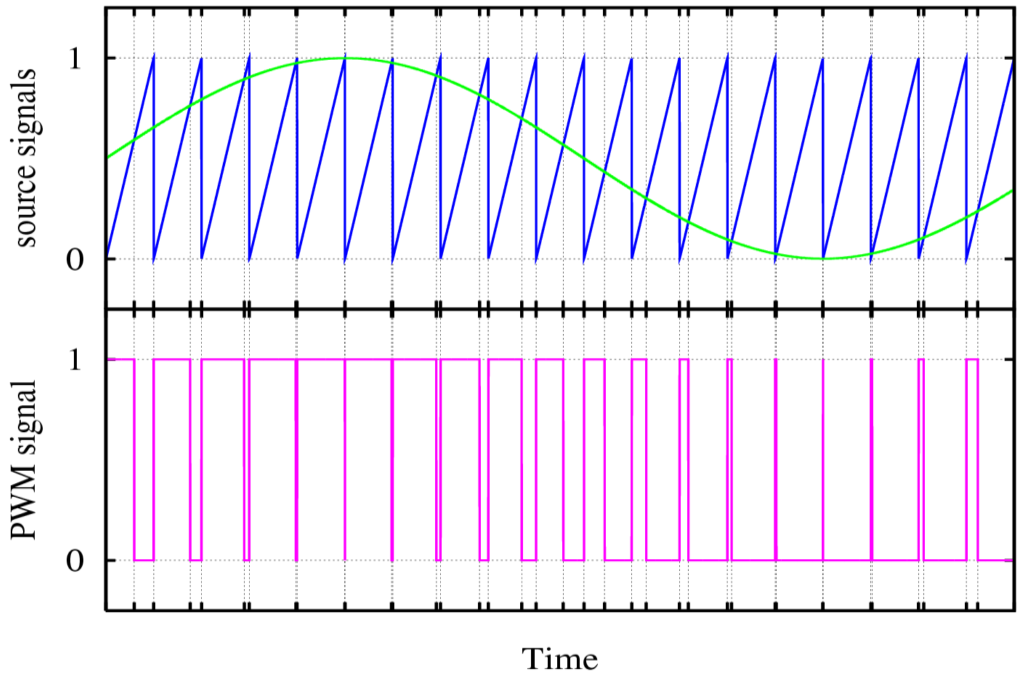

Figure 2.2: Pulse Width Modulation Signal

Source: www.wikipedia.org

Pulse-width modulation (PWM), or pulse-duration modulation (PDM), is a modulation technique that conforms the width of the pulse, formally the pulse duration, based on modulator signal information. Although this modulation technique can be used to encode information for transmission, its main use is to allow the control of the power supplied to electrical devices, especially to inertial loads such as motors.The use of stand-alone micro controller for the speed control of DC motor is past gaining ground. Nicolai and Castagnct have shown in their paper how a micro controller can be used for speed control. The operation of the system can be summarized as: the drive form a rectified voltage, it consists of chopper driven by a PWM signal generated from a micro controller unit (MCU). The motor voltage control is achieved by measuring the rectified mains voltage with the analog to-digital converter present on the micro controller and adjusting the PWM signal duty cycle accordingly. [5]

The term *duty cycle* describes the proportion of 'on' time to the regular interval or 'period' of time; a low duty cycle corresponds to low power, because the power is off for most of the time. Duty cycle is expressed in percent, 100% being fully on. The main advantage of PWM is that power loss in the switching devices is very low. When a switch is off there is practically no current, and when it is on, there is almost no voltage drop across the switch. Power loss, being the product of voltage and current, is thus in both cases close to zero. In the past, when only partial power was needed (such as for a sewing machine motor), a rheostat (located in the sewing machine's foot pedal) connected in series with the motor adjusted the amount of current flowing through the motor, but also wasted power as heat in the resistor element. It was an inefficient scheme, but tolerable because the total power was low. This was one of several methods of controlling power.

There were others—some still in use—such as variable autotransformers, including the trademarked 'Autrastat' for theatrical lighting; and the Variac, for general AC power adjustment. These were quite efficient, but also relatively costly. PWM can be used to control the amount of power delivered to a load without incurring the losses that would result from linear power delivery by resistive means.

Potential drawbacks to this technique are the pulsations defined by the duty cycle, switching frequency and properties of the load. With a sufficiently high switching frequency and, when necessary, using additional passive electronic filters, the pulse train can be smoothed and average analog waveform recovered.High frequency PWM power control systems are easily realisable with semiconductor switches. As explained above, almost no power is dissipated by the switch in either on or off state. However, during the transitions between on and off states, both voltage and current are nonzero and thus power is dissipated in the switches. By quickly changing the state between fully on and fully off (typically less than 100 nanoseconds), the power dissipation in the switches can be quite low compared to the power being delivered to the load.

For about a century, some variable-speed electric motors have had decent efficiency, but they were somewhat more complex than constant-speed motors, and sometimes required bulky external electrical apparatus, such as a bank of variable power resistors or rotating converter such as Ward Leonard drive. However, in addition to motor drives for fans, pumps and robotic servos, there was a great need for compact and low cost means for applying adjustable power for many devices, such as electric stoves and lamp dimmers. One early application of PWM was in the Sinclair X10, a 10 W audio amplifier available in kit form in the 1960s. At around the same time PWM started to be used in AC motor control. [6]

2.5 Speed Control DC Motor Using Microcontroller

Now a days, automatic control systems are used widely to minimize the human errors and increase the production rate with good quality. So most of the machines used in production stream uses induction motors with variable speeds. Using analog methods we can vary the speed, but they are not accurate because of the tolerance of the devices, and also the circuit is complex.

There is a lot of method in controlling DC motor speed, for example Multiple Voltage Control and Ward-Leonard System. In Multiple voltage control method, , the shunt field of the motor is connected permanently to a fixed exciting voltage, but the armature is supplied with different voltages by connecting it across one of the several different voltages by means of suitable switchgear. The armature speed will be approximately proportional to these different voltages. The intermediate speeds can be obtained by adjusting the shunt field regulator.

On the other hands, Ward-Leonard System is used where an unusually wide and very sensitive speed control is required as for colliery winders, electric excavators, elevators and the main drives in steel mills and blooming and paper mills. M1 is the main motor whose speed control is required. The field of this motor is permanently connected across the dc supply lines. By applying a variable voltage across its armature, any desired speed can be obtained. This variable voltage is supplied by a motor-generator set which consists of either a dc or an ac motor M2directly coupled to generator G. The motor M2 runs at an approximately constant speed. The output voltage of G is directly fed to the main motorM1. The voltage of the generator can be varied from zero up to its maximum value by means of its field regulator. By reversing the direction of the field current of G by means of the reversing switch RS, generated voltage can be reversed and hence the direction of rotation of M1. It should be remembered that motor generator set always runs in the same direction

Figure 2.3: Arduino Uno
Source: www.arduino.cc

In order to meet higher performance and reliability requirements, the electric drive systems used in industrial applications are increasingly. The DC motor is an attractive place of equipment in many industrial applications requiring variable speed and load characteristics due to its ease of controllability. Microcontrollers provide a suitable means of meeting these needs. Certainly, part of the recent activity on microcontrollers can be ascribed to their newness and challenge. In this project use microcontroller as controller for the speed controller use PIC.

Another system that uses a microprocessor is reported in the work is reported in journal a brief description the system is as follow: The microprocessor computes the actual speed of the motor by sensing the terminal voltage and the current, it then compares the actual speed of the motor with the reference speed and generates a suitable control signal which is fed into triggering unit.

A simple form of speed control is achieved through a variable potentiometer for a manually controlled system; the operator mentally compares the actual speed to a desired speed and sets the potentiometer accordingly. A simple form of speed control is achieved through a variable potentiometer for a manually controlled system; the operator mentally compares the actual speed to a desired speed and sets the potentiometer accordingly. Updated on the CRT screen each second to a desired speed, he/she corrects the current speed by rotating the potentiometer clockwise to increase or counterclockwise to reduce the speed, by comparing the speed in revolution per seconds (rps). [7]

2.6 Analog to Digital Converter

An analog-to-digital converter (abbreviated ADC, A/D or A to D) is a device that converts a continuous physical quantity (usually voltage) to a digital number that represents the quantity's amplitude. The conversion involves quantization of the input, so it necessarily introduces a small amount of error. The inverse operation is performed by a digital-to-analog converter (DAC). Instead of doing a single conversion, an ADC often performs the conversions ("samples" the input) periodically. The result is a sequence of digital values that have converted a continuous-time and continuous-amplitude analog signal to a discrete-time and discrete-amplitude digital signal.

An ADC is defined by its bandwidth (the range of frequencies it can measure) and its signal to noise ratio (how accurately it can measure a signal relative to the noise it introduces). The actual bandwidth of an ADC is characterized primarily by its sampling rate, and to a lesser extent by how it handles errors such as aliasing. The dynamic range of an ADC is influenced by many factors, including the resolution (the number of output levels it can quantize a signal to), linearity and accuracy (how well the quantization levels match the true analog signal) and jitter (small timing errors that introduce additional noise). The dynamic range of an ADC is often summarized in terms of its effective number of bits (ENOB), the number of bits of each measure it returns that are on average not noise. An ideal ADC has an ENOB equal to its resolution. ADCs are chosen to match the bandwidth and required signal to noise ratio of the signal to be quantized. If an ADC operates at a sampling rate greater than twice the bandwidth of the signal, then reconstructions possible given an ideal ADC and neglecting quantization error. The presence of quantization error limits the dynamic range of even an ideal ADC, however, if the dynamic range of the ADC exceeds that of the input signal, its effects may be neglected resulting in an essentially perfect digital representation of the input signal.

Recently, a fully digital approach to generate a test stimulus by PWM used for high resolution ADCs has been reported with a focus on static test [8]. The advantage of this technique is that a 1-bit data pulse train can convey the wanted test signal without harmonic distortions that is particularly attractive for on-chip test. This is in contrast to the true analog techniques or DA conversion based techniques implemented on a chip, where the spectral purity of the generated signals can be difficult to guarantee.

The other technique, i.e. uniform-PWM is relatively simpler to implement digitally but suffers from harmonic distortion components of the modulating signal. Different algorithmic approaches have been reported to reduce the harmonic content and improve SNR, including enhanced sampling process [9]